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Observations

on

"The connection, and reciprocal influence

between the vital functions and mechanical force".

For the degree

of

Doctor of Medicine.

in the

University of Pennsylvania.

By

Robt. R. Reed.

Penna.

Observations &c.

It were an easy task to trace the improvement of the rational powers from the time when Man

"— a rad barbarian, roving, mixed
With beasts of prey; or for his acorn meal
Fought the fierce tusky boar; a shivering wretch."

to the period when

"— Society grew numerous, high, polite
And happy ——"

But the occasion does not demand it:— I shall therefore merely adduce one of the most splendid illustrations of this improvement which can be offered for our consideration, viz: Medicine.

This science may boast a greater antiquity than any other, — indeed in some one of its various departments, it has been almost coeval with the human race. As has been beautifully observed — "It cannot be supposed that uninterrupted health was ever among our happy privileges, and mankind always liable to accidents and diseases would naturally seek the measures of mitigation and

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relief."+ But it was not till the revolution so much needed both in the intellectual & the material world ~~was~~ was unfolded — when Descartes, and after him, Malebranche & Locke, began with daring hands to tear aside the veil which had so long shrouded ~~the~~ intellectual philosophy — when the mighty efforts of Newton and Bacon gave a new face to the philosophy of the material world, that Medicine advanced in the proud march she has followed and which has lead to the high ~~station~~ rank she now holds. To Sydenham is due the credit of first applying to Medicine the inductive method of reasoning, which had been so happily employed in the other branches of science, and which so well entitles him to the distinguished appellation of "the restorer of Medicine."

Medical Science is not now confined to a mere observation of diseases, or to "the dry detail of pharmaceutical operations." Its sphere is more extensive, embracing in its range every department of Nature. The medical philosopher now makes as legitimate objects of his study, the delightful discoveries of Botany and the splendid researches of Chemistry

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Anatomy and Physiology unfold all the wonders of organization; ~~and~~ Mineralogy reveals to him her hidden treasures and even the several branches of science are made subservient to his purposes.

I would not revive the absurd doctrines of the visionary Asclepiades, and resolve all the operations of Life into Matter and Motion. Nor have I any ambition to restore to a place in medical Philosophy the theories of the mechanical Physicians, who calculated the laws of the animal economy by the strict rules of Geometry, and represented the human system as made up of ropes and pullies and levers, combined with ducts and tubes, whose united operation they were wont to compute just as they would estimate the power of a pump or an engine!

My object in the following pages will be fulfilled by shewing "The connection and reciprocal influence between the vital functions and mechanical forces."

A knowledge of the principle upon which the vital functions depend for their operation, has ever been a desideratum with Physiologists; and the

Anima Medica of Stahl, the Archeus of Van Helmont and the bio medicatrix of later times, has each in turn been reckoned the source of all vital action, and has successively furnished an explanation of the ~~vital~~ Phenomena of Life, satisfactory to the respective theorists and their followers. And now what remains of these systems, and a host of others that might be enumerated, save their memory? The human mind is too limited even to attain a knowledge of first causes. Here, as in the material world, we are checked in our attempts to learn the essences of things; — the result of certain modifications in each department forms the "ultima Thule" of our researches ——

We must be content then with knowing what Life does and remain forever ignorant of what Life is.

The vital functions are certain operations carried on by systems, or parts of the same structure and cooperating in the performance of the same office.
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The first are those which are under the influence of the Will; the second are such as are removed beyond its influence and the last are partially controlled by Volition. Let a function of the last kind be made the subject of our inquiries, viz: Respiration.

Respiration may properly be called a mixed function; for though indeed generally the motions of the chest are performed spontaneously, yet it will be hereafter shewn that an act of the Will can accelerate, retard or modify their motions.

This is one of the most important functions of the system; - indeed, on its proper performance the continuance of all the rest depends. It may be simply defined "the inspiration and expiration of air, following the dilatation and contraction of the chest."

Two kinds of Phenomena are to be shewn in Respiration. One sort are entirely mechanical, as the motions of the Thorax, by which its cavity is expanded or diminished - the dilatation and contraction of the

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air vessels, and the ingress and egress of air which follow these motions. The latter kind are altogether chemical, such as the changes of the blood and inspired air &c. With the former kind alone we have to do at present.

In order to shew the connection between this function and mechanical force, and the mutual influence exerted between them, it will be necessary briefly to describe some of the parts concerned in its performance.

The Thorax, in which this function is carried on, is a conoidal, bony cavity, of a mean capacity between that of the head, and of the abdomen; and capable of dilatation and contraction in three directions, viz: perpendicularly, transversely and anteroposteriorly.

The principal motive powers in ordinary Respiration are, the ribs, with their cartilages, — the diaphragm and the intercostal muscles. The mechanism of the chest is admirably designed for the exercise of great power. This is especially true of the ribs, which by their

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But let us examine the muscular power, (and muscular power is nothing but mechanical force) employed in the function of Respiration.

In the perpendicular dilatation and contraction of the Thorax, the Diaphragm is mainly concerned. This powerful muscle, it is ascertained, can move in the direction of its operation, about three inches; and has been computed to possess an effect in dilating ~~the~~ and contracting the chest, five times greater than all the other powers employed. From its primary importance in the execution of this function, it may readily be conceived how great the disturbance which would result from its injury or disability. This will be shewn when we come to consider the function in its diseased action.

The intercostal muscles are the chief agents in altering the transverse diameter of the chest. These muscles are of two kinds, external and internal.

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They are attached to the Ribs, and operate by a kind of compound motion. Their tendency is, when they contract, to elevate the ribs; and they, from the obliquity of their position, cannot be raised without having their middle portion carried outwards; and thus they alter the transverse diameter.

Each of these important operations is assisted by other subordinate agents, some of which will be mentioned in their place. The antero-posterior direction is so little affected and the agency so inconsiderable as not to deserve notice here.

To apply what has been stated in illustration: Let us take an infant at birth. The function of Respiration, although every thing requisite for its operation is ready, has been as yet unemployed. The little stranger is exposed to the air, and what takes place? The air does not rush into the Lungs, as some Physiologists would say, to fill the vacuum. There is no vacuum. The lungs lie folded up, the interstices of the air cells are closed and the whole organ is

pressed upon by the sides of the chest, and by the diaphragm. As body is inert and passive, and cannot, of itself, produce motion; so, this state of things would continue, unless the vital principle exerted its powers. The atmosphere, operating as a stimulant, calls into exercise this mysterious principle, and the infant is directed to contract the Diaphragm, and to elevate the Ribs. Then indeed, a vacuum is produced, and the air, by its tendency to an equilibrium, is forced into the Lungs.

I may be told that an infant, at birth, has not the exercise of its Will. To this, I would answer, that as the first increments of the velocity which carries forward the tremendous avalanche, are not perceptible, so the first developements of the mind of a Newton, are exceedingly feeble and indistinct.

Nothing is more certain than that many sensations are perceived, and many actions performed without consciousness, yet the mind is still employed.

The operation of expiration is easily understood.

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All muscular force is weakened by continuance; and its agents are fatigued by their own action. There is therefore a tendency soon observed, to return to the opposite state, especially if there has been in operation a counteracting power. This is precisely the case with the moving powers of the Lungs; for whilst one set of muscles is employed in enlarging the diameter of the chest, another set is as intently engaged in attempting its contraction. This latter tendency have most of the muscles of the abdomen. Some of them are inserted into the Ribs, and endeavour to restore them, when elevated, to their proper places. To all these forces, must be added the elasticity of the Ribs themselves and their cartilages, which is by no means inconsiderable.

More adequate conceptions may be had of the astonishing force exerted by the muscles subservient to Respiration, when we consider the experiment, so often tried, of a person lying on his back and supporting on his breast, the immense weight of a large anvil,

to which is added the force of hammering. - Here, the vital principle, ever alive to the preservation of the system over which she presides, directs the strong dilatation of the chest; and for this purpose, the external muscles (particularly the serrati) draw the ribs powerfully outwards, and resisting their depression, form an arch which can sustain a weight with impunity, that would inevitably crush the sternum and ribs of a dead body.

We have thus hastily considered the operation of muscular force in healthy respiration: - we shall now view the subject in regard to its operation in disease.

Let us take the case of a wound of the Diaphragm. What a disturbance of the function now occurs! The vital principle soon recovers from her panic, and directs the total quiescence of the injured muscle, quickening into more active exercise, the ordinary agents of respiration, and pressing into her service, others hitherto unemployed. The scapulae and

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clavicular muscles, with others that might be enumerated, are modified in their action; - their fulcra become moveable points; and by their united operations they are enabled to fulfil the purposes of the disabled organs.

Again - let a rib be fractured, or let the pleura costalis be inflamed; and what do we witness?

The intercostals cease their operations. - the Diaphragm redoubles its exertions, calling to its assistance all the auxiliary muscles of the abdomen; and thus subserves the purposes of Respiration, without the co-operation of the intercostals.

These respective phenomena might be examined as they are to be observed in Ascites, in Pregnancy and in Consumption; and we might consider the mechanical force exerted in the various modifications of the function, in coughing, sneezing, yawning &c.; - but my limits will not permit. I shall hasten to consider the subject in relation to the Lungs themselves

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which admit the air into their cavity; of a peculiar tissue, of which the air cells are constituted, and of the pulmonary and bronchial arteries and veins.

An opinion has been entertained by some physiologists, that the Lungs themselves are entirely passive in the operation of Respiration; but it would seem to me that an examination of their structure were only needed, to convince any one that these organs exert a very considerable degree of mechanical force in the performance of the function.

Granting the least possible degree of elasticity to the air cells, and considering their amazingly extended surface, the amount of force exerted in their even partial collapse must be by no means inconsiderable.

But admitting that the air cells are entirely devoid of the property of elasticity, we know that the air tubes exhibit a muscular structure for some distance, and if we might infer its existence

in their infinite ramifications, when it may exclude our scrutiny, what an immense force must they not exercise in their contractions? Yet on the supposition that muscular structure is deficient, we may fairly infer, from the known resiliency of the tubes in their whole extent, that a very high degree of power must be exercised in the expansion and collapse of the organs, of which they make so great a part. If to all these be superadded the natural elasticity of the pulmonary and nutritious arteries, we may surely set down to the Lungs, the exercise of very great mechanical power.

It might be well, did time permit, to consider the amount of force, (purely mechanical) exemplified in the pressure of the atmosphere, in its various states of rarefaction and density. It was also my intention to have extended these views to at least another of the vital functions, Circulation; but from this I am precluded by the pressure of study and my prescribed limits.

J. T. Heston

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